

Life cycle studies of *Protaetia aurichalcea* (Cetoniinae:Cetoniidae:Scarabaeidae) in household biocompost

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ABSTRACT

Composting is a process that safeguards and conditions diversity of decomposing ecosystem with the help of micro and macro-organisms. The focus of the present study was macro-fauna in the compost. During this work, the infamously labelled agricultural pest, a scarab beetle was found living through compost, completing its life cycle without ever coming out of the compost bin thus helping the composting as well. The paper describes the observations of its life cycle studies.

Keywords: Compost fauna, India, Scarab beetle, *Protaetia aurichalcea*, Lifecycle.

1. INTRODUCTION

Scarab beetles in India are studied mainly as an agricultural pests and secondly to as an inventory to locate their diversity. During present study, scarab beetle *Protaetia aurichalcea* was found in compost completing its entire life cycle without ever coming out of the compost bin. This was the first time this beetle was observed in compost and its last reference in Indian context was found in Fauna of British India including Ceylon and Burma by Arrow (1910) hence it was chosen for the study.

2. MATERIALS AND METHODS

Site selection

Household biocompost plant in Thane city (Maharashtra: India) was selected. The compost feedstock included biodegradable kitchen waste, household and garden waste.

Rearing

A laboratory culture was raised for beetles as well as their larvae and pupae. Optimum air, temperature and moisture conditions were maintained in the units in which these were reared. The food of larvae under study consisted of organic matter, decaying wood or trash and other debris accumulated. Ritcher (1966) described the similar food habits for all larvae belonging to sub family Cetoniinae.

Life cycle observations - Description of life stages:

Copulation

The mating in *P. aurichalcea* (Figure 1) was observed to be 6-8 minutes while repetitive mating behaviour between the same pair during the same day was also seen. The mating period of *Holotrichia consanguinea*, beetle from Melolonthinae family has been described to be 2-6 minutes by Brar and Sandhu (1980). While it was recorded to be 4-7 minutes by various Indian researchers (Bindra and Singh, 1971; Yadava and Saxena, 1977; Sukhija et al. 1979). Once the copulation was over, male and female separated and female burrowed down herself in the organic matter for egg laying. After 2-3 days of copulation, egg laying was observed. In a life span of one and a half months, on an average a single female laid 45-50 eggs. All the eggs were not laid in one day and the eggs were laid singly.

The egg

The egg measured between $2.0 - 2.3 \pm 0.1$ mm in length and $1.0 - 2.2 \pm 0.1$ mm in breadth (Figure 2). In *Chiloloba orientalis* it was measured to be $2.0 - 4.0 \pm 2.4$ mm by Kumbhar et al., (2012). The incubation period under laboratory conditions varied as per the seasons with minimum 8 days in all seasons while maximum duration varying from 11 to 26 days. Kumbhar et al., (2012) reported that eggs of *Chiloloba orientalis* hatched within 11-18 days.

Larva

Larva showed growth in three instars before undergoing pupation. The C shaped creamy white larva with orange setae and head capsule, showed growth in three instars before undergoing pupation. The three pairs of thoracic legs were very weak hence it crawled on its back. The food of larva under study consisted of organic matter, decaying wood or trash and other debris accumulated. Ritcher (1966) described the similar food habits for all larvae belonging to sub family Cetoniinae.

1st instar

The body length of newly hatched larva to mature 1st instar larva (head to lower anal lip) ranged from 3.0 ± 0.2 mm to 15 ± 0.2 mm (Figure 3). In *Protaetia fusca*, it was recorded as 11.00 mm by Simpson (1990). The body weight ranged between 0.01 ± 0.01 mg to 10.00 ± 0.2 mg from newborn to mature 1st instar larva. Mico and Galante (2003) described similar larval morphological characters with respect to size, shape, colour and weight for *Tropinota squalida* (Scopoli), *Aethiessa floralis* (Fabricius) and *Oxythyrea funesta* (Poda) belonging to the subfamily Cetoniinae. Moults of first instar larvae were observed from eighth day till twenty fourth day of hatching from the eggs in some larvae (Figure 4).

2nd instar

Body length measured from 15.00 ± 0.2 mm to 25.00 ± 0.2 mm throughout this instar (Figure 5). The body weight of fresh larva was 12.00 ± 0.2 mg and that of mature larva was 60.00 ± 0.23 mg. Spiracles were enlarged in proportion with the body girth in second instar. The moults of second instar larvae were observed from fourteenth day till fortieth day of hatching out from the eggs in some larvae (Figure 6).

3rd instar

The body length of fresh third instar larva was 25.00 ± 0.2 mm (Image 1.5) and mature larva was 35.00 ± 0.1 mm in length. The fresh third instar grub weighed 60.00 ± 0.2 mg whereas the mature white grub was bulky and weighed as much as 160.00 ± 0.25 mg (Figure 7).

Larvae of third instar fed voraciously in the first few days, gained maximum possible weight, later became less active and sluggish and underwent pupation. Similar observations were made by Sipek (2009). The average weight before pupation was 135mg and the length ranged between 30-35 mm but it shrivelled up in preparation for a change

to the pupal stage. As reported by Veenakumari and Veeresh (1996), the larva before attaining the pupal stage does not feed further and considerably shrinks its size and shows very little movement even when disturbed.

Sexual differentiation in the larva was done at 3rd instar. On the middle of the proximal third of the last abdominal segment, the male had a chitinous deposition called “Herold’s organ” between the raster pattern. It looked like a small black or brown spot from which male could be differentiated (<http://pagesperso-orange.fr/serge.mallet/sexcetoE.html>).

When matured 3rd instar larva prepared earthen cocoon for pupation, it moulted inside the cocoon unlike the previous 2 moultings. Hence the 3rd larval moult was found inside the cocoon (Figure 8) The larval duration under laboratory conditions ranged between 46-111 days with least (46) in summer and longest (111) in winter. In *Holotrichia serrata*, the average larval duration was 148.7 days as noted by Majumdar and Teotia (1965).

Pupal chamber/Earthen cocoon

Larva took almost 8-11 days to build the cocoon of faecal pellets which were very rough externally but interior was even walled and consisted of fine soil particles adhered with the saliva of the grub (Figure 9) Last larval moult and pupal moult (Figure 10) enclosed was seen inside the empty cocoon after adult broke it and emerged out. Similar observations were recorded by Simpson (1990) for the pupal chamber of *Protaetia fusca* and by Veenakumari and Veeresh (1996) in another scarab beetle *O.gazella*.

Pupa

Pupa was exarate i.e. the wings and legs were free from the body and the abdomen was movable (Figure 11). The pupa made the earthen cocoon with the support of one of the wall of the transparent thus the earthen cocoon was closed from three sides and thus the pupal development was visible through the container.

The observations were as follows-

2nd day- Formation of Scutellum began.

8th day- Formation of wings

10th day- Elytra seen curled below the abdomen.

12th day- Development of legs seen. Femora were long and dorsoventrally flattened. Tibiae were terminating with spurs. Tarsi were 5 segmented while claws were sharp, bifid and with basal empodium.

14th day- Body colouration started and shining dark brown coloured mesothoracic leg as well as Pygidium seen.

16th day -White spots/ scales appeared on the elytra. The elytra had tinge of light brown colour and bright white spots were clearly visible while the pygidium was dark brown in colour.

20th day- The colour of the elytra became intense copper brown with bright spots on it. The adult was formed and emerged out of cocoon.

This was the pupal development in winter and monsoon when pupa metamorphosed in just 19 days. Duration of pupa varied from 20-36 days with minimum 20 days in summer and maximum 36 days in winter. In *Protaetia fusca* this pupal period was recorded up to 4.0 ± 0.2 weeks by Simpson (1990) while Rai et al., (1969) observed it to be only 13 days for the same beetle *H. consanguinea* under laboratory conditions.

Adult

Freshly emerged adult was active and lustrous, however if undisturbed it remained quiescent for couple of days. Its approximate size was 14-20 mm x 8-10.5 mm. The shape was short and broad, rather depressed and very little narrowed behind. The imago was deep bronze in colour and had very shining appearance on the dorsal and ventral surface (Figure 12). It had opaque white markings, consisting of a large irregular patch on each side of the pronotum (Figure 13).

Feeding habit of adult

The beetles were kept in large plastic containers at room temperature with optimum temperature and moisture. The beetle came on the surface (of the compost) only for feeding and sometimes for mating when observed in captivity. Being a soil inhabitant, the beetle buried down after eating and mating. The adult preferred to eat pulpy matter of fruit (Figure 14). While rearing in the laboratory, the beetles were provided with fruits like apple, banana and sapota. Under lab conditions and when provided with regular supply of fresh food, adult survived up to 60-75 days.

3. RESULTS

This beetle was attracted to the compost fauna due to the added feedstock in it. The beetle fed itself and laid eggs as it found the compost favourable for the larvae. This was corroborated with the observations by Dutto (2005, 2007).

The larvae consumed the organic matter, pupated and the life cycle continued. Larval excreta were in the form of pellets and the study of its chemical parameters revealed that they are equally nutrient rich in Nitrogen, Phosphorus and Potassium when compared to vermicompost. This study was supported by Kühnelt (1976), as according to him the larvae of the rose chafer (Cetoniinae) are very active digesters of organic materials in the soil. They mix organic and inorganic materials and redeposit them in the form of cylindrical pieces of excrement. While the shortest lifecycle duration of *P. aurichalcea* was 78 days in winter and longest was 137 days in summer, another species, *P. orientalis* took one year to complete as reported by Lijima and Takeuchi (2007).

4. DISCUSSION AND CONCLUSION

Sighting of scarab beetle *Protatetia aurichalcea* during the study led to the study of its lifecycle. In its subject review, it was observed that this beetle was not studied, though the other beetles belonging to family Cetoniinae (Scarabaeidae) were recorded as agricultural pests in India as well as abroad. Since, it was the first time this beetle was observed in the compost; its study was considered essential. After observing it in all the stages, it was noted that this beetle helped in composting in larval as well as adult stage. The constant tunnelling of larva transferred the microbes and air through the compost and its excreta improved the nutrient status. Similarly adult fed on leftover vegetable matter and this cutting of leftover food in small pieces provided more surface area for the microbes to act upon it. Moreover, the beetles never came out of the compost plant and therefore never caused any nuisance. Thus it can be concluded that, along with microbes in compost, the macro organisms should also be studied and rather than labelling all the scarabs as pests and killing them, they should be put to better use by rearing them in compost.

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Figure 1

Mating in *P. Aurichalcea*



Figure 2

The egg

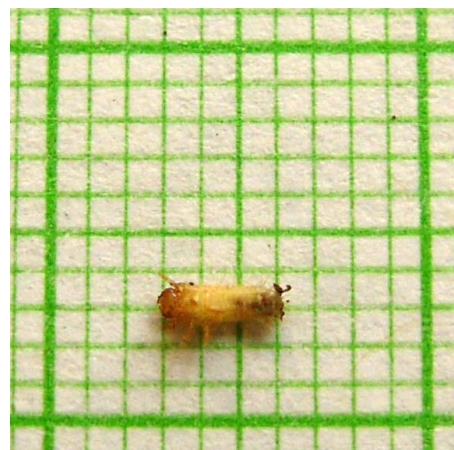


Figure 3

Body length of newly hatched larva



Figure 4

First instar larvae



Figure 5

Body length of first instar larvae



Figure 6

Moults of second instar larvae



Figure 7

Fresh third instar larva



Figure 8

Body length of fresh third instar



Figure 9

The cocoon of faecal pellets



Figure 10

Last larval moult and pupal moult

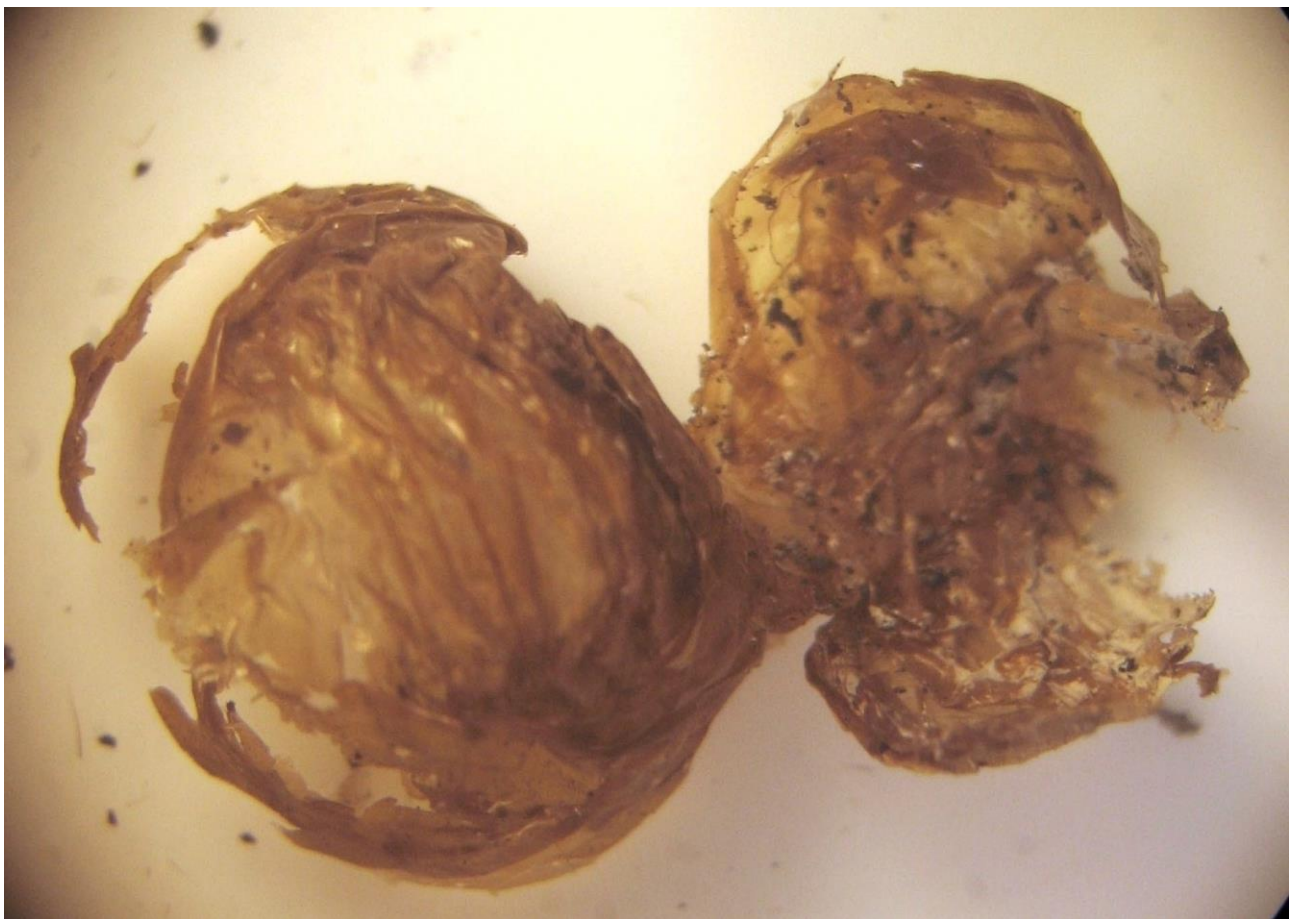


Figure 11

The wings and legs were free from the body and the abdomen was movable



Figure 12

The imago



Figure 13

The imago had opaque white markings, consisting of a large irregular patch on each side of the pronotum



Figure 14

The adult preferred to eat pulpy matter of fruit